International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 9 Issue 1, Jan-Feb 2025 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Drones in Architecture

Matthew N. O. Sadiku[1], Paul A. Adekunte[2], Janet O. Sadiku[3]

[1]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA
[2]International Institute of Professional Security, Lagos, Nigeria
[3]Juliana King University, Houston, TX, USA

ABSTRACT

Architecture is the art and science of designing buildings and other physical structures. Architects give importance to precision, and with drones architects no longer need to undergo rigid processes to get an aerial view of an area. Drones are already shaping the face of our cities, used for building planning, heritage, construction, and safety enhancement. Drone technology is playing a key role in redefining how we maintain, build, and design properties. Architects mainly use drones for generating photographic views and developing their projects from particular angles. Researchers and architecture companies are already experimenting with building with drones. This paper focuses on drone applications in the architecture industry.

KEYWORDS: *drones, unmanned aircrafts, unmanned aerial vehicles (UAVs), architecture*

How to cite this paper: Matthew N. O. Sadiku | Paul A. Adekunte | Janet O. Sadiku "Drones in Architecture" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-9 | Issue-1, February 2025, pp.282-288, URL: www.ijtsrd.com/papers/ijtsrd73860.pdf

IJTSRD73860

INTRODUCTION

As far as architecture is concerned, there is always a change in technology and design. There is no denying the technological transformation that architecture is currently undergoing. From design software to electronic utilities and applications, architecture is growing into one of the most technically savvy professions in the world. One of the notable technologies that has accelerated the transformation is the drone.

Unmanned aerial vehicles (UAVs), commonly called drones, are gaining in popularity among professionals working in the Architecture, Engineering, and Construction (AEC) industry, which an industry that involves the design, engineering, and construction of buildings, infrastructure, and other physical structures. Drones were initially designed and built for military purposes, but they have been lately designed to serve non-military fields. Drones made their first appearance to the general public in 2006. Some years ago, using commercial drones would have been laughably unrealistic, but now they are in daily use on construction sites around the world. Drone technology is revolutionizing the design, construction, and maintenance of buildings. Today, large AEC companies like AECOM are regularly using drones to survey sites, monitor resources, and track project progress. International companies like Kespry and senseFly offer drones that are relatively easy to use and come with full-support packages.

WHAT IS A DRONE?

At least three terms are used to describe drones, depending on how they are operated. The terms include Unmanned Aerial Vehicles (UAVs), Unpiloted Aircraft System (UAS), and Remote Piloted Aircraft System (RPAS). The FAA defines drones, also known as unmanned aerial vehicles (UAVs), as any aircraft system without a flight crew onboard. Drones include flying, floating, and other devices, including unmanned aerial vehicles (UAVs), that can fly independently along set routes using an onboard computer or follow commands transmitted remotely by a pilot on the ground. A typical drone is shown in Figure 1 [1]. A drone is usually controlled remotely by a human pilot on the ground, as typically shown in Figure 2 [1]. Drones can range in size from large military drones to smaller drones. Drones,

previously used for military purposes, have started to be used for civilian purposes since the 2000s. Since then, drones have continued to be used in intelligence, aerial surveillance, search and rescue, reconnaissance, and offensive missions as part of the military Internet of things (IoT). Today, drones are used for different purposes such as aerial photography, surveillance, agriculture, entertainment, healthcare, transportation, law enforcement, etc.

Drones work much like other modes of air transportation, such as helicopters and airplanes. When the engine is turned on, it starts up, and the propellers rotate to enable flight. The motors spin the propellers and the propellers push against the air molecules downward, which pulls the drone upwards. Once the drone is flying, it is able to move forward, back, left, and right by spinning each of the propellers at a different speed. Then, the pilot uses the remote control to direct its flight from the ground [2],

Drone laws exist to ensure a high level of safety in the skies, especially near sensitive areas like airports. They also aim to address privacy concerns that arise when camera drones fly in residential areas. These include the requirement to keep your drone within sight at all times when airborne. In the United States, drones weighing less than 250g are exempt from registration with civil aviation authorities. If your drone exceeds 250g in weight, you will also require a Flyer ID, which requires passing a test [3]. It is necessary to register as an operator, be trained as a pilot, and have civil liability insurance, in addition to complying with various flight regulations, and those of the places where their use is permitted.

Most drones have a limited payload, usually under 11 pounds. Drones are classified according to their size. Here are the different drone types:

- Nano Drone: 80-100 mm
- Micro Drone: 100-150 mm
- Small Drone: 150-250 mm
- Medium Drone: 250-400 mm
- Large Drone: 400+ mm

One of the emerging trends in drone use for factories is the utilization of LiDAR technology. LiDAR stands for Light Detection and Ranging. This technology provides accurate depth information essential for understanding the three-dimensional structure of the environment. LiDAR sensors emit laser beams to measure distances to objects, creating high-resolution 3D maps of the surrounding terrain and objects. The ability to capture detailed data through LiDAR technology has opened up opportunities for better predictive maintenance, reduction in inspection times, and overall cost savings [4].

DRONES IN ARCHITECTURE

The Architecture, Engineering, and Construction (AEC) services sector provides a host of services surrounding the planning and building of commercial and residential projects that employ design and construction professionals in the planning and implementation of projects. One of the most compelling reasons to use a drone in architecture is aerial photography. Drones in architecture are redefining site analysis, inspections, surveying, and project documentation for architects. Properties located in scenic environments, such as those with mountain views, lakes, or extensive gardens, can significantly benefit from aerial shots.

Drones for architects have improved the architecture and construction industry, considering that it has given them the eyes that work best for jobs where precision and monitoring are essential. A drone will enable one to capture the tiniest of details and showcase a particular structure from every possible angle. The use of drone technology is becoming more and more common among architectural firms as a tool for site analysis, visualization, and project management. The advancement in drone technology is bound to influence architecture more than ever before. A typical example of drones in architecture is shown in Figure 3 [5].

APPLICATIONS OF DRONES IN ARCHITECTURE

Drones offer various functions throughout the building's lifecycle, including assessing site conditions, aiding in site planning, capturing construction progress photos, performing 3D scans of existing structures, creating virtual building models, assisting with maintenance, and supporting marketing efforts. The areas of drone applications include surveying and mapping, progress monitoring, safety monitoring, and asset maintenance. Common areas of applications include [6]:

- *Photography:* One of the best characteristics regarding the use of drones is their ability to capture hard-to-take images. It is impossible to grasp a land structure without seeing it in an aerial view. Before drones became helpful in architecture, construction companies would hire people to do an aerial view. Today, everyone is using drones to photograph buildings from the sky. Drone photography showcases three things: unique perspective, location, and scale. Drones equipped with high-resolution cameras and sensors can capture detailed aerial images and data of the project site. Drone architecture photography produces precise images from an aerial perspective. Aerial photography captured

by drones has become an asset to architects' building projects because it provides architects with a unique perspective of the site and its surroundings. Modern architecture often times looks stunning from the top down. Certain properties, particularly those with expansive lots, may require aerial photography to capture the entire space effectively. An aerial view of a building is shown in Figure 4 [7].

- *Planning:* In site planning and layout, drones' aerial images combined with site plans provide accurate and visual representations of the building's features and their placement on the site. This helps designers and owners visualize the project and accommodate geographic features and variables accurately. With a more accurate photo of the actual land area, it is much easier to create a layout and design of the construction area. Drones in architecture enhance design visualization and allow design to become immersive and compelling.
- *Progress Monitoring:* It is very hard to keep track of construction projects as they involve many teams and can be spread out over a large site. Fixed cameras onsite may not be able to cover the entire site in detail, failing to capture critical progress information. Drones serve as vigilant overseers, monitoring construction progress and ensuring adherence to designs. They enable architects to monitor the construction process and track progress. They can create accurate 2D maps and 3D models of the site on-demand.
- *Building Inspection:* Traditional inspections often require teams to implement manual, rope-access techniques which require walking across rooftops and scaffolding. This is time-consuming and dangerous. It is often difficult to visualize the building in its entirety, and manual inspections do not produce standardized digital results. Drones can take high-resolution close-up photos of buildings to create detailed models for inspection. They can assist in building inspections, especially for large or complex structures. They can be used to inspect building facades, roofs, and other inaccessible areas without the need for manual intervention. Figure 5 shows the essential civic building of the future, a project designed by a student in Spain [8]. It shows how architecture can be "an engine of development and innovation.
- *Site Inspection:* The first and foremost consideration in architectural design is the physical context of any construction site. Site analysis and inspections are traditionally characterized by manual surveys, satellite images, and site visits, which take a lot of time and resources. Drones capture bird-eye views, helping architects understand topography, neighboring structures, and even shadow patterns. The use of drones has changed this working environment by providing a more accurate way of obtaining more efficient and accurate data. Drones fitted with high-definition cameras and laser imaging technology, often termed LiDAR (light detection and ranging), serve architects by creating detailed 3D maps and models of the site.
- *Drone Delivery:* The arrival of drone delivery services will see significant changes to buildings in our communities. A proposal for a drone delivery center is a serious example of an urban opportunity. Current models are still too weak to carry heavy materials, but they can easily carry very powerful cameras. A typical delivery drone is shown in Figure 6 [9].

BENEFITS

When it comes to architecture, the deployment of drones brings several benefits, including improved efficiency and reduced costs. Drones can survey sites, inspect construction quality, and photograph completed buildings, with more powerful capabilities in sight. They present significant opportunities to improve quality, reduce costs, improve decision-making, and mitigate safety risks in construction projects. It is a lot easier to fly a drone over a miles-long mining site that spans mountains and ravines than it is to send in a team of surveyors. Other benefits include the following [10]:

- *Reputation*: One of the foremost advantages is the improvement of design. Using drones to create high-quality 360° videos for your 3D modeling will also give you a competitive edge. Drones in architecture influence a company's reputation as they enhance their services. They give the impression that a company aims for a modernized workplace and services. You will truly impress your clients and turn them into repeat customers.
- *Risk Reduction:* Drones reduce the need to place staff and resources in a position of risk, allow repeatability to surveys, examinations and assessments, and offer a rapid and economical way of acquiring data.
- *Efficiency:* Drones bring efficiency, accuracy, and novel perspectives to the architectural process. Drones make architectural work more efficient as they lessen human effort by letting them control a drone remotely. Drones for architecture monitoring are a cost-effective solution to rising construction expenses. All the help that drones

have offered in the architecture and construction industry saves many companies time and money. Embracing this technology not only spells efficiency and precision but sets the stage for futuristic, sustainable, and safer building designs.

- *Sustainable Architecture:* 21st-century architectural designs aim to contribute to sustainable architecture, which aims to help in the environmental movement. Drone architecture monitoring is made possible and lets architects create pleasing and environmentally friendly designs.
- *Cost Reduction:* Using drones is not just cost-effective but also saves time. It saves a lot of money and prevents any unwanted accidents that might cost lives.

CHALLENGES

Despite the numerous advantages offered by drones, they have not gained widespread acceptance in facade inspection due to some restrictive local ordinances. The most important thing about flying a drone is to obtain a license or permit. If you fly your drone in a restricted area, you will get a fine. Other challenges include the following [10]:

- *Limitations*: Regulatory limitations include not being able to fly after dark, out of operator's line of sight, above certain altitudes, and near other structures or above crowds. Current models are still too weak to carry heavy materials, but they can easily carry very powerful cameras. If you are operating an unmanned aircraft that weighs less than 55 pounds, generally you may apply for a Part 107 waiver (special permission) to conduct your operation.
- *Regulations:* Some EU countries, including Czech Republic, France, Germany, Ireland, Italy, the Netherlands, Norway, Romania, and Sweden, have national regulations, while many others have still not addressed the issue.

CONCLUSION

The adoption of commercial drones in the AEC industry has been rapid partly because it aids in effectively sharing data and resolving challenges faced on construction sites. It might take a while before we see programmed drones build entire habitable buildings, but they can already contribute a great deal in surveying building sites, gathering site data, monitoring construction work, and creating marketing materials. Because drones can be used extensively in many phases of a project, they are becoming essential tools in the field of architecture. Having a drone at the disposal of an architectural practice allows architects in the company to be proactive. Some architects dream of using drones to actually build a building. Given the rate at which drone technology has advanced in the past decade and the amount of money being invested in the area, it is likely that the dream will become reality. More information about drones in the architecture industry can be found in the books in [11,12].

REFERENCES

[1] "Drone in construction & infrastructure," https://www.jouav.com/industry/drone-in-construction

[2] "How drones work and how to fly them," May 2024, https://dronelaunchacademy.com/resources/how-do-drones-work/

[3] "What are the main applications of drones?" June 2024, https://www.jouav.com/blog/applications-of-drones.html

[4] "Drones in manufacturing: A game-changer for industry," https://viper-drones.com/industries/infrastructure-drone-use/manufacturing/#:~:text=The%20integration%20of%20drones%20into,on%20manufacturing%20is%20no%20exception.

[5] "Architecture and drones," https://www.re-thinkingthefuture.com/product-design/a6106-architecture-and-drones/#google_vignette

[6] "Architecture, engineering, and construction services," https://www.trade.gov/architecture-and-engineering-services#:~:text=The%20Architecture%2C%20Engineering%2C%20and%20Construction,multi%2Dbillion%2Ddollar%20projects.

[7] "When to use a drone for architectural photography: A guide for architects, designers, and photographers," https://www.austinlaruephotography.com/architecturalphotographyblog/when-to-use-a-drone-for-architectural-photography-a-guide-for-architects-designers-and-photographers#:~:text=One%20of%20the%20most%20compelling,significantly%20benefit%20from%20aerial%20shots.

[8] S. Lam, "This student project shows how droneports could be the train stations of the 21st century," December 2016, https://www.archdaily.com/801464/this-student-project-shows-how-droneports-could-be-the-train-stations-of-the-21st-century

[9] "Five ways drones will change the way buildings are designed," December 2022, https://theconversation.com/five-ways-drones-will-change-the-way-buildings-are-designed-195611

[10] L. Grozdanic, "How drones can be used in architecture (and how to use them without breaking the law)," January 2018, https://www.archdaily.com/886743/how-drones-can-be-used-in-architecture-and-how-to-use-them-without-breaking-the-law

[11] D. Tal and J. Altschuld, *Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation.* Wiley, 2021.

[12] P. Cureton, *Drone Futures: UAS in Landscape and Urban Design.* Routledge, 2020.

Figure 1 A typical drone [1].

Figure 2 A drone is usually controlled by operators on the ground [1].

Figure 3 A typical example of drones in architecture [5].

Figure 4 An aerial view of a building [7].

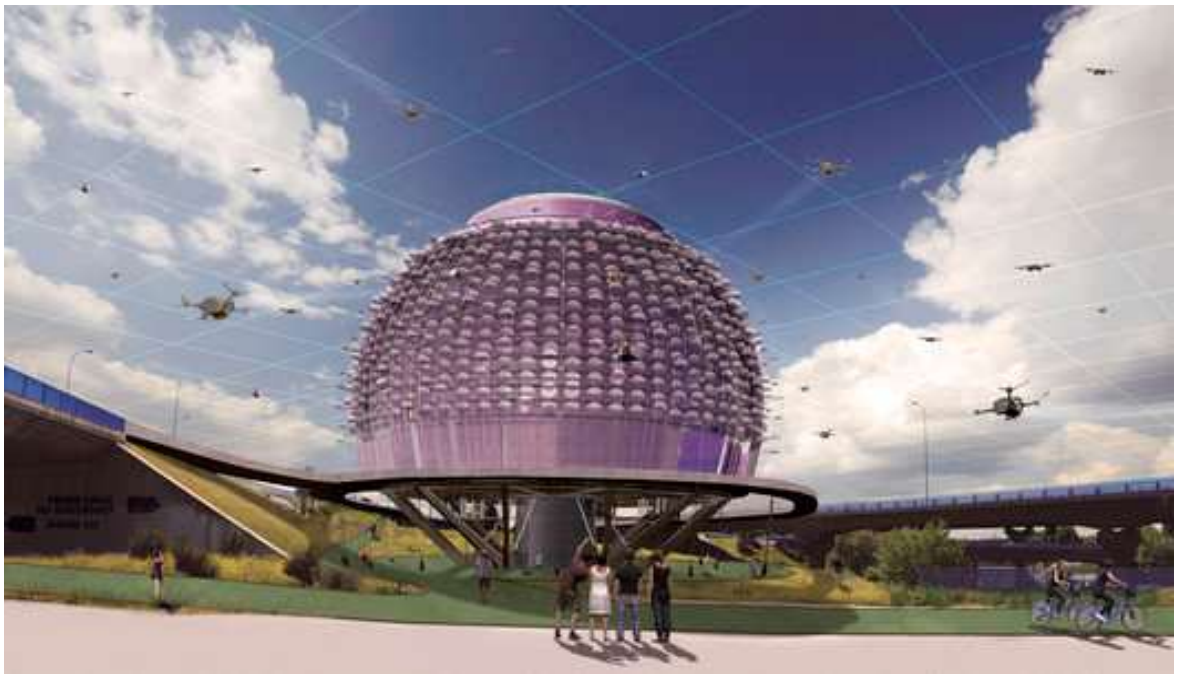

Figure 5 The essential civic building of the future [8].

Figure 6 A typical delivery drone [9].